

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

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U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

10/030936

INTERNATIONAL APPLICATION NO.
PCT/DE 00/02234INTERNATIONAL FILING DATE
JULY 8, 2000PRIORITY DATE CLAIMED
JULY 20, 1999

TITLE OF INVENTION

A LAYER THAT CONTAINS ELECTRICALLY CONDUCTIVE, TRANSPARENT MATERIAL, A METHOD FOR
PRODUCING SUCH A LAYER, AND THE USE OF SAID LAYER

APPLICANT(S) FOR DO/EO/US

Peter KNOLL, Hagen KLAUSMANN, Ewald-Theodor GINTER, Joachim GLUECK, Erhard HOFFMANN, Martin
HUEPPAUFF, Frank DRUSCHKE

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 18 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
A **SECOND** or **SUBSEQUENT** preliminary amendment.
16. ☐ A substitute specification.
17. ☐ A change of power of attorney and/or address letter.
18. ☒ Certificate of Mailing by Express Mail
19. ☐ Other items or information:

ET 755324075 US

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.01(b)) 10/030936		INTERNATIONAL APPLICATION NO. PCT/DE 00/02234		ATTORNEY'S DOCKET NUMBER 1980							
20. The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) : <input type="checkbox"/> Search Report has been prepared by the EPO or JPO \$930.00 <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) \$720.00 <input type="checkbox"/> No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) \$790.00 <input checked="" type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$1,070.00 <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$98.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY <table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="height: 40px;"></td><td></td></tr> <tr><td style="text-align: right;">\$890.00</td><td></td></tr> <tr><td style="text-align: right;">\$0.00</td><td></td></tr> </table>				\$890.00		\$0.00	
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Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				\$0.00							
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE								
Total claims	33 - 20 =	13	x \$18.00	\$234.00							
Independent claims	1 - 3 =	0	x \$80.00	\$0.00							
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				\$0.00							
TOTAL OF ABOVE CALCULATIONS =				\$1,124.00							
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). <input type="checkbox"/>				\$0.00							
SUBTOTAL =				\$1,124.00							
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				\$0.00							
TOTAL NATIONAL FEE =				\$1,124.00							
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				\$0.00							
TOTAL FEES ENCLOSED =				\$1,124.00							
				Amount to be: refunded	\$						
				charged	\$						
<input type="checkbox"/> A check in the amount of _____ to cover the above fees is enclosed.											
<input checked="" type="checkbox"/> Please charge my Deposit Account No. 19-4675 in the amount of \$1,124.00 to cover the above fees. A duplicate copy of this sheet is enclosed.											
<input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 19-4675 A duplicate copy of this sheet is enclosed.											
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.											
SEND ALL CORRESPONDENCE TO:											
STRIKER, STRIKER & STENBY 103 EAST NECK ROAD HUNTINGTON, NEW YORK 11743			<div style="text-align: center;"> </div> SIGNATURE <hr/> MICHAEL J. STRIKER <hr/> NAME <hr/> 27233 <hr/> REGISTRATION NUMBER <hr/> JANUARY 14, 2002 <hr/> DATE								

UNITED STATES PATENT AND TRADEMARK OFFICE

Examiner: Group: Attorney Docket # 1980

Applicant(s) : KNOLL, P., ET AL

Serial No. :

Filed :

For : A LAYER THAT CONTAINS ELECTRICALLY,
CONDUCTIVE, TRANSPARENT MATERIAL, A
METHOD FOR PRODUCING SUCH A LAYER, AND
THE USE OF SAID LAYER

SIMULTANEOUS AMENDMENT

January 14, 2002

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

S I R S:

Simultaneously with filing of the above identified application
please amend the same as follows:

In the Claims:

Cancel all claims without prejudice.

Substitute the claims attached hereto.

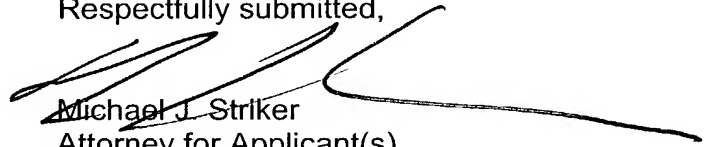
REMARKS:

This Amendment is submitted simultaneously with filing of the above identified
application.

With the present Amendment applicant has amended the claims so as to eliminate
their multiple dependency.

Consideration and allowance of the present application is most respectfully requested.

Respectfully submitted,



Michael J. Striker
Attorney for Applicant(s)
Reg. No. 27233

Claims

1. A layer on a substrate, which contains an organic, transparent, electrically conductive material, characterized in that the layer has a preferred orientation.
2. The layer according to claim 1, characterized in that the material is a polymer.
3. The layer according to claim 2, characterized in that the polymer is a doped polymer.
4. The layer according to claim 3, characterized in that the doped polymer is a mixture of a polymer, which is from the group including polythiophenes, polyacetylenes, polypyrroles, polyanilines, and the like, and at least one polyanion, which is preferably comprised of organic compounds containing di- and polyhydroxy- and/or carboxylic acid- or sulfonic acid groups, and particularly preferably, polyanions comprised of polycarboxylic acids or polysulfonic acids.
5. The layer according to claim 4, characterized in that the doped polymer is polyethylene dioxythiophene polystyrene sulfonate (PEDT/PSS).
6. The layer according to claim 2 [or 3], characterized in that the polymer has been produced by means of photopolymerization.
7. The layer according to claim 6, characterized in that the polymer is photo-oriented.
8. The layer according to [one of claims 2 to 6] claim 2, characterized in that the polymer was modified in such a way that it became photo-cross-linkable and was then photo-cross-linked.

9. The layer according to claim 8, characterized in that the polymer has been modified by means of photo-cross-linkable substituents.

10. The layer according to claim 8 [or 9], characterized in that the polymer is photo-oriented.

11. The layer according to claim 10, characterized in that the polymer was modified by means of photo-cross-linkable substituents, which induce a privileged direction when irradiated with linearly polarized light, and was then cross-linked and photo-oriented by means of at least one irradiation with polarized light.

12. The layer according to [one of claims 1 to 11] claim 1, characterized in that it also contains a bonding agent.

13. The layer according to claim 12, characterized in that the bonding agent is a polymer that is cross-linked by means of irradiation.

14. The layer according to claim 12 [or 13], characterized in that the bonding agent is photo-oriented.

15. The layer according to claim 14, characterized in that the bonding agent is a polymer, which is anisotropically cross-linked by irradiation with linearly polarized light.

16. The layer according to [one of claims 1 to 15] claim 1, characterized in that the layer constitutes a pattern of layer segments.

17. The layer according to [one of claims 1 to 5 and 12] claim 1, characterized in that the conductivity in the layer is selectively nullified.

18. A method for producing a layer, in particular according to [one of claims 1 to 17] claim 1, in which an organic, electrically conductive, transparent layer is produced on a substrate, characterized in that the layer is oriented.

19. The method according to claim 18, characterized in that a layer, which contains a transparent, electrically conductive material, is produced on the substrate.

20. The method according to claim 19, characterized in that a polymer is used as this material.

21. The method according to claim 20, characterized in that the starting material for the polymer is polymerized in the presence of at least one compound, which is capable of anion formation, and one oxidation agent.

22. The method according to claim 21, characterized in that a mixture is brought to reaction, which contains a monomer selected from the groups including thiophenes, polyacetylenes, polypyrroles, polyanilines, and the like, at least one organic compound containing di- and polyhydroxy- and/or carboxylic acid- or sulfonic acid groups, preferably at least one polycarboxylic acid or one polysulfonic acid, and an oxidation agent.

23. The method according to claim 20, characterized in that the starting material for the polymer is polymerized by irradiation.

24. The method according to claim 23, characterized in that the starting material for the polymer polymerizes, forming a privileged direction, when irradiated with linearly polarized light.

25. The method according to [one of claims 20 to 23] claim 20, characterized in that the conductive polymer is modified with photo-cross-linkable substituents and is then cross-linked by irradiation.

26. The method according to claim 25, characterized in that the doped polymer is modified with photo-cross-linkable substituents, which anisotropically cross-link when irradiated with linearly polarized light, and is then cross-linked by at least one irradiation with linearly polarized light.

27. The method according to [one of claims 18 to 26] claim 18, characterized in that the starting material for the layer has a bonding agent or the starting material for such a bonding agent added to it.

28. The method according to claim 27, characterized in that a photo-cross-linkable polymer is used as a starting material for the bonding agent.

29. The method according to claim 28, characterized in that a photo-cross-linkable polymer is used as the starting material for the bonding agent and this polymer anisotropically cross-links when irradiated with linearly polarized.

30. The method according to [one of claims 18 to 23, 25, 27, and 28] claim 18, characterized in that the layer is oriented by means of friction.

31. The method according to [one of claims 18 to 30] claim 18, characterized in that the layer, possibly at the same time as the photo-polymerization or the photo-cross-linking and possibly the photo-orientation, is photolithographically structured by means of selective etching.

32. The method according to [one of claims 18 to 22, 26 and 29] claim 18, characterized in that the conductivity in the layer is selectively nullified photolithographically by means of an oxidation agent.

Claims

1. A layer on a substrate, which contains an organic, transparent, electrically conductive material, characterized in that the layer has a preferred orientation.
2. The layer according to claim 1, characterized in that the material is a polymer.
3. The layer according to claim 2, characterized in that the polymer is a doped polymer.
4. The layer according to claim 3, characterized in that the doped polymer is a mixture of a polymer, which is from the group including polythiophenes, polyacetylenes, polypyrroles, polyanilines, and the like, and at least one polyanion, which is preferably comprised of organic compounds containing di- and polyhydroxy- and/or carboxylic acid- or sulfonic acid groups, and particularly preferably, polyanions comprised of polycarboxylic acids or polysulfonic acids.
5. The layer according to claim 4, characterized in that the doped polymer is polyethylene dioxythiophene polystyrene sulfonate (PEDT/PSS).
6. The layer according to claim 2, characterized in that the polymer has been produced by means of photopolymerization.
7. The layer according to claim 6, characterized in that the polymer is photo-oriented.
8. The layer according to claim 2, characterized in that the polymer was modified in such a way that it became photo-cross-linkable and was then photo-cross-linked.
9. The layer according to claim 8, characterized in that the polymer has been modified by means of photo-cross-linkable substituents.

10. The layer according to claim 8, characterized in that the polymer is photo-oriented.

11. The layer according to claim 10, characterized in that the polymer was modified by means of photo-cross-linkable substituents, which induce a privileged direction when irradiated with linearly polarized light, and was then cross-linked and photo-oriented by means of at least one irradiation with polarized light.

12. The layer according to claim 1, characterized in that it also contains a bonding agent.

13. The layer according to claim 12, characterized in that the bonding agent is a polymer that is cross-linked by means of irradiation.

14. The layer according to claim 12, characterized in that the bonding agent is photo-oriented.

15. The layer according to claim 14, characterized in that the bonding agent is a polymer, which is anisotropically cross-linked by irradiation with linearly polarized light.

16. The layer according to claim 1, characterized in that the layer constitutes a pattern of layer segments.

17. The layer according to claim 1, characterized in that the conductivity in the layer is selectively nullified.

18. A method for producing a layer, in particular according to claim 1, in which an organic, electrically conductive, transparent layer is produced on a substrate, characterized in that the layer is oriented.

19. The method according to claim 18, characterized in that a layer, which contains a transparent, electrically conductive material, is produced on the substrate.

20. The method according to claim 19, characterized in that a polymer is used as this material.

21. The method according to claim 20, characterized in that the starting material for the polymer is polymerized in the presence of at least one compound, which is capable of anion formation, and one oxidation agent.

22. The method according to claim 21, characterized in that a mixture is brought to reaction, which contains a monomer selected from the groups including thiophenes, polyacetylenes, polypyrroles, polyanilines, and the like, at least one organic compound containing di- and polyhydroxy- and/or carboxylic acid- or sulfonic acid groups, preferably at least one polycarboxylic acid or one polysulfonic acid, and an oxidation agent.

23. The method according to claim 20, characterized in that the starting material for the polymer is polymerized by irradiation.

24. The method according to claim 23, characterized in that the starting material for the polymer polymerizes, forming a privileged direction, when irradiated with linearly polarized light.

25. The method according to claim 20, characterized in that the conductive polymer is modified with photo-cross-linkable substituents and is then cross-linked by irradiation.

26. The method according to claim 25, characterized in that the doped polymer is modified with photo-cross-linkable substituents, which anisotropically cross-link when

irradiated with linearly polarized light, and is then cross-linked by at least one irradiation with linearly polarized light.

27. The method according to claim 18, characterized in that the starting material for the layer has a bonding agent or the starting material for such a bonding agent added to it.

28. The method according to claim 27, characterized in that a photo-cross-linkable polymer is used as a starting material for the bonding agent.

29. The method according to claim 28, characterized in that a photo-cross-linkable polymer is used as the starting material for the bonding agent and this polymer anisotropically cross-links when irradiated with linearly polarized.

30. The method according to claim 18, characterized in that the layer is oriented by means of friction.

31. The method according to claim 18, characterized in that the layer, possibly at the same time as the photo-polymerization or the photo-cross-linking and possibly the photo-orientation, is photolithographically structured by means of selective etching.

32. The method according to claim 18, characterized in that the conductivity in the layer is selectively nullified photolithographically by means of an oxidation agent.

33. A use of the layer according to claim 1
as a combined electrode- and orientation layer in LC displays.

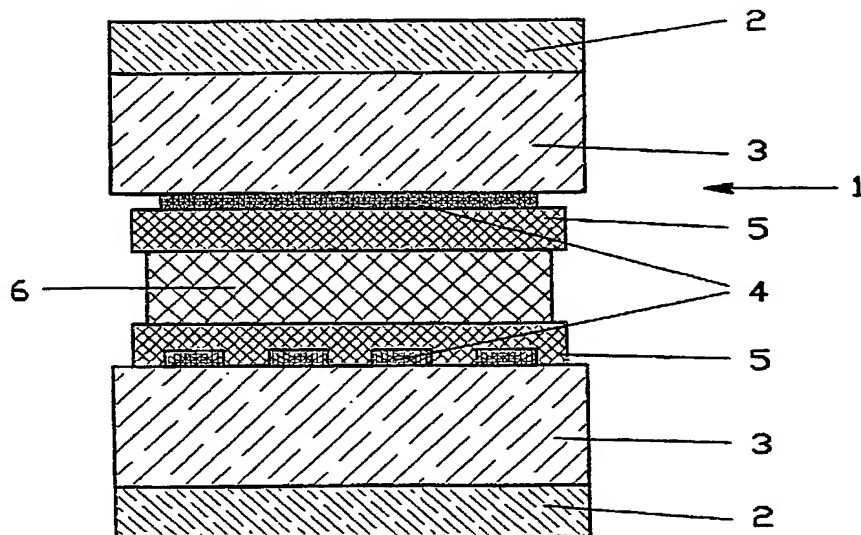
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[Fortsetzung auf der nächsten Seite]

(54) Title: LAYER CONTAINING AN ELECTROCONDUCTIVE TRANSPARENT MATERIAL, METHOD FOR PRODUCING
SAME AND USE THEREOF(54) Bezeichnung: EINE SCHICHT, DIE ELEKTRISCH LEITFÄHIGES, TRANSPARENTES MATERIAL ENTHÄLT, EIN
VERFAHREN ZUR HERSTELLUNG EINER SOLCHEN SCHICHT UND DEREN VERWENDUNG

(57) Abstract: The invention aims at providing a structure acting as an electroconductive structured organic transparent electrode and an orienting layer, and an inexpensive and time-saving method for producing such a structure, and the uses of said structure. To achieve this aim, a layer is provided on a substrate, containing an electroconductive organic transparent material with a preferred orientation. The invention also concerns a method for producing such a layer, which consists in producing and orienting an electroconductive transparent layer on a substrate, and the use of such a layer in liquid crystal displays, as electrode layer with combined orientation.

[Fortsetzung auf der nächsten Seite]

WO 01/06306 A2

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A Layer That Contains Electrically Conductive, Transparent Material, a Method for Producing Such a Layer, and the Use of Said Layer

Prior Art

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The invention relates to a layer that contains an organic, transparent, electrically conductive material, a method for producing such a layer, and the use of said layer, in particular in LC displays.

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Conventional LC displays have two glass substrates that are coated on one side with a polarization filter and on the other side with a structured electrode (one of the electrodes can also be unstructured) made of indium tin oxide (ITO), which is coated with an orientation layer, for example made of polyimide. The orientation layer is used to induce a privileged direction of molecules, for example, parallel to one surface. The orientation is usually produced by means of friction. With the orientation layers, the coated glass substrates define the opposite surfaces of a liquid crystal. ITO is deposited by means of sputtering in a vacuum process, which is expensive. This is followed by the structuring of the ITO layer by means of photolithography, in which the exposed ITO is etched away by means of HBr or HCl and HNO₃. The above-mentioned materials and process steps make the production of the layer structure expensive and time-consuming.

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Among other things, the European patent applications 0440975 and 0686662 have disclosed organic, electrically conductive polythiophene derivatives; the latter application mentions, among other things, using polyethylene dioxythiophenes as electrode material for LC displays. The polythiophenes are produced by thiophenes being oxidatively polymerized, particularly in the presence of polyacids. During the polymerization, the polythiophenes are given positive charges. The polymer produced is deposited onto the glass substrate and is converted into the layer by drying and optional tempering. This production is simpler and less expensive than the production of ITO layers. The structuring of the organic, conductive polymers is somewhat less expensive than that of

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ITO because no strong anorganic acids have to be used for the etching. The method for producing the entire layer structure of LC displays, however, remains quite expensive.

5 The Invention and Its Advantages

The object of the invention is to disclose a structure, which performs the functions of a structured, organic, electrically conductive, transparent electrode and an orientation layer, a cost-reducing and time-saving method for producing such a structure, and uses of
10 this structure.

This object is attained with a layer of the type mentioned at the beginning, which is characterized in that the layer is oriented by means of a method of the type mentioned at the beginning, in which layers produced in a conventional manner are oriented, which
15 contain an organic, electrically conductive, transparent material, and is attained with the use of the layer in an LC display as a combined electrode and orientation layer. The layer according to the invention thus renders an additional orientation layer superfluous. As a result, the method for producing LC displays can be executed in a manner that saves a significant amount of time and expense without becoming more complex, because its
20 execution only makes use of conventional process steps and devices. The layer according to the invention is particularly used in LC displays in which it replaces the previously conventional structure made up of an electrically conductive, transparent electrode and an orientation layer. The structure according to the invention is thus embodied more simply than known structures and can be produced with fewer process steps and the materials are
25 cheaper and more environmentally friendly.

It is advantageous if the material is a doped polymer, which is preferably a mixture of a polymer, which is selected from the group including polythiophenes, polyacetylenes, polypyrroles, polyanilines, and the like, at least one polyanion, which is
30 preferably comprised of organic compounds containing di- and polyhydroxy- and/or

carboxylic acid- or sulfonic acid groups, and particularly preferably at least one polyanion comprised of polycarboxylic acids or polysulfonic acids. In this connection, a “doped” polymer is understood to be a polymer which has been modified by means of oxidation or reduction reactions to form a charge-transfer complex with a metallic, electrical conductivity characteristic.

It is advantageous if the conductive polymer was produced by means of photo-induced or electron beam polymerization or if the conductive polymer was modified in such a way that it became photo-cross-linkable, and was then photopolymerized (in the following, the terms “photopolymerization” and “photo-cross-linking” will always be used for both photopolymerization and electron beam polymerization as well as for both photo-cross-linking and electron beam cross-linking). With polymers of this kind, the method can be simplified particularly if the layer, for example for use in an LC display, must be photolithographically structured by means of selective etching, because the production of a photoresistive masking can then be eliminated.

Such a simplification can also be achieved if the layer contains – optionally in addition to the photopolymerized or photo-cross-linked conductive polymer – a bonding agent that is a polymer, which has been cross-linked by irradiation. This multitude of possibilities permits flexible adaptation to other requirements of the method.

It is favorable if the photopolymerizable starting material for the polymer, the cross-linkable polymer, and/or the cross-linkable bonding agent can also be photo-oriented because in the irradiation for the polymerization or cross-linking, when linearly polarized light is used, for example by virtue of the illumination being routed through the polarization filter of the LC display, the orientation of the layer or at least the induction of the privileged direction or the setting of the tilt angle can be executed at the same time.

However, the orientation can also be advantageously produced – as in conventional orientation layers – by means of friction, because it has surprisingly been

determined that this orientation method also functions with electrode layers comprised of organic, electrically conductive materials.

Other advantageous embodiments of the layer according to the invention and the
5 method according to the invention ensue from the dependent claims.

The Drawings

The invention will be described in detail below in conjunction with exemplary
10 embodiments explained by means of drawings.

Fig. 1 schematically depicts a cross section through a conventional LC display according to the prior art, and

15 Fig. 2 is a schematic, cross-sectional depiction of an LC display that contains the structure according to the invention.

Description of Exemplary Embodiments

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Fig. 1 depicts the structure of an LC display 1 according to the prior art. A polarization filter 2 has a glass substrate 3 affixed to it, with an electrically conductive layer 4 mounted thereon, which is comprised of ITO or an organic, electrically conductive polymer such as polyethylene dioxythiophene polystyrene sulfonate (PEDT/PSS). The
25 PEDT/PSS-containing layer is produced in an intrinsically known manner in that the solution of an oxidation agent, such as potassium peroxydisulfate, in water, has a thiophene, such as 3,4-ethylene dioxythiophene, and a polyacid, such as polystyrene sulfonic acid, added to it and is then stirred for approx. 8 hours; the polythiophene dispersion obtained is then deposited onto the substrate by spraying, immersion, or a
30 printing process – optionally, after being mixed with a bonding agent, such as polyvinyl

alcohol or polyvinyl acetate —, and is then dried and tempered. The layer thicknesses lie between approx. 10 nm and approx 1 μ m, preferably between approx. 100 nm and approx. 500 nm. The layer 4 is structured. The structuring takes place — provided that a printing process has not been used — photolithographically by virtue of the fact that a photoresistive layer is applied to the layer 4 and is irradiated and developed in accordance with the desired structure, and then the exposed regions of the layer 4 are etched away by means of HBr or HCl and HNO₃ when the layer material is ITO, and by means of an organic solvent or powerfully basic solutions when the material is organic, such as PEDT/PSS. Alternatively, it is also possible, through selective treatment with a potassium permanganate solution, to nullify the conductivity of the treated locations in the layer material. An orientation layer 5, for example comprised of polyimide, is deposited onto the structured layer 4 and is oriented by means of friction, for example by means of a velvet cloth. The structure produced and a structure that is also comprised of the layers 2 to 5 — however, layer 4 can also be unstructured — are arranged parallel to one another so that the orientation layers are oriented toward each other and enclose a fixed intermediary space. The intermediary space is filled with a liquid crystal 6.

The exemplary embodiment of an LC display, which is described below in conjunction with Fig. 2 and contains the layer according to the invention, and the exemplary embodiments of methods for producing such an LC display are in fact particularly advantageous, but it should be clearly understood that they are only mentioned by way of example and that numerous deviations from them are possible within the scope of the claims.

Fig. 2 shows an LC display 10 that contains the layer according to the invention. A polarization filter 2 has a glass substrate 3 affixed to it, with an electrically conductive, transparent layer 14 thereon, which preferably contains a polymer, which is selected from the group including polythiophenes, polyacetylenes, polypyrroles, polyanilines, derivatives of the above-mentioned compounds, and the like, a polyanion, for example the anion of a polycarboxylic acid or polysulfonic acid, and possibly a bonding agent such

as polyvinyl alcohol or polyvinyl acetate. A particularly advantageous combination of one of the above-mentioned polymers and one of the above-mentioned polyanions is PEDT/PSS. The layer thicknesses lie in the same range as in the known layers. The layer 14 is structured. By contrast with the known LC display, no orientation layer is deposited on the layer 14; in fact, it has surprisingly turned out that the layer 14 can be oriented by means of friction and therefore can also perform the function of the orientation layer. The structure produced and a structure that is also comprised of the layers 2, 3, and 14 – layer 4 can also be unstructured – are disposed parallel to one another so that the electrode layers are oriented toward each other and enclose a fixed intermediary space. The intermediary space is filled with a liquid crystal 6.

In order to produce the layer structure, first the polymer is produced in that the solution of an oxidation agent, such as potassium peroxydisulphate in water, has a thiophene, such as 3,4-ethylene dioxythiophene, and a polyacid, such as polystyrene sulfonic acid, added to it, and is then stirred for between a few minutes and 30 hours, preferably between 30 minutes and 10 hours. Then the dispersion obtained, which contains the polythiophene and the polyanion, is deposited onto the substrate, for example by means of spraying or immersion, possibly after the addition of a bonding agent, and is then dried and tempered. The structuring is preferably executed in a photolithographic manner (see above) through selective etching or selective nullification of the conductivity of the layer 14. Finally, the layer obtained is oriented by means of friction. The steps of structuring and orientation can also be reversed.

Alternatively, the layer material can be produced by means of irradiation. There are numerous possibilities for this. The starting material for the transparent, electrically conductive material can be a photopolymerizable resin, which is polymerized by irradiation after being deposited onto the substrate. Another way is to produce the electrically conductive polymer and then to cross-link it by irradiation. The conductive polymer in this case can be produced either – as described above – through oxidative polymerization or through the above-mentioned polymerization by irradiation. In photo-

cross-linking, the process can, for example, be executed so that the conductive polymer is modified by means of photo-cross-linkable substituents, i.e. substituents such as an acrylic acid derivative that contains, for example, at least one multiple bond (thus rendering the conductive polymer photo-cross-linkable) and is then photo-cross-linked by irradiation.

Finally, it is also possible to mix the conductive polymer with the starting material of a bonding agent, which is photo-cross-linkable, and then to cross-link the starting material by irradiation. In so doing, the conductive polymer bonded into a matrix comprised of the bonding agent. Starting materials can include, for example, a photoresistive coating, acrylic acid resins, or methacrylic acid resins.

It is also possible on the one hand, to produce the final form of the conductive polymer by means of photopolymerization and/or photo-cross-linking and on the other hand, to produce the bonding agent by means photo-cross-linking.

The polymerization or cross-linking by irradiation is advantageous particularly if the layer containing the conductive polymer is to be structured, because the production of a structured photoresistive layer is then eliminated. As a result, the method for producing the electrode layer is significantly simplified and chronologically shortened (the process steps with which the photoresistive masking is produced are eliminated) and the number of acquired materials is reduced (in addition to the photoresist, the developer is also eliminated).

Friction is not the only way in which an orientation can be imparted to a polymer. In the orientation process, advantageous use can be made of the property, which causes some photo-cross-linkable polymers or their photopolymerizable and/or photo-cross-linkable starting materials to orient themselves when irradiated with linearly polarized light. This is referred to as so-called photo-orientation. Conductive layers that are produced from materials, which can be both photo-cross-linked and photo-oriented, can

be produced, for example, by the conductive polymer being mixed with a polymer that serves as a bonding agent, which when irradiated with a linearly polarized light, cross-links in an anisotropic manner, i.e. forms a privileged direction. Possible polymers of this type include, for example, stilbene derivatives and cinnamic acid derivatives.

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However, with these compounds, an illumination is required in order to induce the privileged direction and to adjust the tilt angle. Alternatively, it is also possible to change the conductive polymer with substituents, which induce a privileged direction through their cross-linking when irradiated with linearly polarized light. Derivatives of cinnamic acid and stilbene can be cited as examples of such substituents. Therefore in general, the materials, which appear to be usable, are those that contain a substituent with a high steric demand in the 1- or 2-position of a double bond. The advantage achieved lies in the fact that the photo-cross-linking and the photo-orientation are produced in the same process step.

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In summary, it can be said that with the use of the electrode according to the invention in LC displays, in comparison to the prior art, the number of layers is reduced by two and its manufacture is reduced at least by the steps, which must be executed in the depositing of two orientation layers, and with a favorable selection of starting materials for the conductive polymer and/or the bonding agent, a considerable further number of process steps can be eliminated. In conjunction with the simplification of the method, materials can also be saved, which is significant to cost considerations and to the environmental friendliness of the method. It goes without saying that by contrast with the electrodes made of ITO that are already in current use, the costly sputtering process can be eliminated.

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Claims

1. A layer on a substrate, which contains an organic, transparent, electrically
conductive material, characterized in that the layer has a preferred orientation.

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2. The layer according to claim 1, characterized in that the material is a polymer.

3. The layer according to claim 2, characterized in that the polymer is a doped
polymer.

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4. The layer according to claim 3, characterized in that the doped polymer is a
mixture of a polymer, which is from the group including polythiophenes, polyacetylenes,
polypyrroles, polyanilines, and the like, and at least one polyanion, which is preferably
comprised of organic compounds containing di- and polyhydroxy- and/or carboxylic acid-
or sulfonic acid groups, and particularly preferably, polyanions comprised of
polycarboxylic acids or polysulfonic acids.

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5. The layer according to claim 4, characterized in that the doped polymer is
polyethylene dioxythiophene polystyrene sulfonate (PEDT/PSS).

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6. The layer according to claim 2 or 3, characterized in that the polymer has been
produced by means of photopolymerization.

7. The layer according to claim 6, characterized in that the polymer is photo-
oriented.

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8. The layer according to one of claims 2 to 6, characterized in that the polymer
was modified in such a way that it became photo-cross-linkable and was then photo-
cross-linked.

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9. The layer according to claim 8, characterized in that the polymer has been modified by means of photo-cross-linkable substituents.

5 10. The layer according to claim 8 or 9, characterized in that the polymer is photo-oriented.

11. The layer according to claim 10, characterized in that the polymer was modified by means of photo-cross-linkable substituents, which induce a privileged direction when irradiated with linearly polarized light, and was then cross-linked and
10 photo-oriented by means of at least one irradiation with polarized light.

12. The layer according to one of claims 1 to 11, characterized in that it also contains a bonding agent.

15 13. The layer according to claim 12, characterized in that the bonding agent is a polymer that is cross-linked by means of irradiation.

14. The layer according to claim 12 or 13, characterized in that the bonding agent is photo-oriented.
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15. The layer according to claim 14, characterized in that the bonding agent is a polymer, which is anisotropically cross-linked by irradiation with linearly polarized light.

16. The layer according to one of claims 1 to 15, characterized in that the layer
25 constitutes a pattern of layer segments.

17. The layer according to one of claims 1 to 5 and 12, characterized in that the conductivity in the layer is selectively nullified.

18. A method for producing a layer, in particular according to one of claims 1 to 17, in which an organic, electrically conductive, transparent layer is produced on a substrate, characterized in that the layer is oriented.

5 19. The method according to claim 18, characterized in that a layer, which contains a transparent, electrically conductive material, is produced on the substrate.

20. The method according to claim 19, characterized in that a polymer is used as this material.

10 21. The method according to claim 20, characterized in that the starting material for the polymer is polymerized in the presence of at least one compound, which is capable of anion formation, and one oxidation agent.

15 22. The method according to claim 21, characterized in that a mixture is brought to reaction, which contains a monomer selected from the groups including thiophenes, polyacetylenes, polypyrroles, polyanilines, and the like, at least one organic compound containing di- and polyhydroxy- and/or carboxylic acid- or sulfonic acid groups, preferably at least one polycarboxylic acid or one polysulfonic acid, and an oxidation
20 agent.

23. The method according to claim 20, characterized in that the starting material for the polymer is polymerized by irradiation.

25 24. The method according to claim 23, characterized in that the starting material for the polymer polymerizes, forming a privileged direction, when irradiated with linearly polarized light.

25. The method according to one of claims 20 to 23, characterized in that the conductive polymer is modified with photo-cross-linkable substituents and is then cross-linked by irradiation.

5 26. The method according to claim 25, characterized in that the doped polymer is modified with photo-cross-linkable substituents, which anisotropically cross-link when irradiated with linearly polarized light, and is then cross-linked by at least one irradiation with linearly polarized light.

10 27. The method according to one of claims 18 to 26, characterized in that the starting material for the layer has a bonding agent or the starting material for such a bonding agent added to it.

15 28. The method according to claim 27, characterized in that a photo-cross-linkable polymer is used as a starting material for the bonding agent.

20 29. The method according to claim 28, characterized in that a photo-cross-linkable polymer is used as the starting material for the bonding agent and this polymer anisotropically cross-links when irradiated with linearly polarized.

30. The method according to one of claims 18 to 23, 25, 27, and 28, characterized in that the layer is oriented by means of friction.

25 31. The method according to one of claims 18 to 30, characterized in that the layer, possibly at the same time as the photo-polymerization or the photo-cross-linking and possibly the photo-orientation, is photolithographically structured by means of selective etching.

32. The method according to one of claims 18 to 22, 26 and 29, characterized in that the conductivity in the layer is selectively nullified photolithographically by means of an oxidation agent.

5 33. A use of the layer according to one of claims 1 to 17 or the layer produced according to one of claims 18 to 32 as a combined electrode- and orientation layer in LC displays.

Abstract

In order to disclose a structure, which performs the functions of a structured,
organic, electrically conductive, transparent electrode and an orientation layer, a cost-
5 reducing and time-saving method for producing such a structure, and uses of this
structure, the invention proposes a layer on a substrate, which layer contains an organic,
transparent, electrically conductive material and which has a preferred orientation, a
method for producing such a layer, in which a transparent, electrically conductive layer is
produced and oriented on a substrate, and a use of such a layer as a combined electrode-
10 and orientation layer in LC displays.

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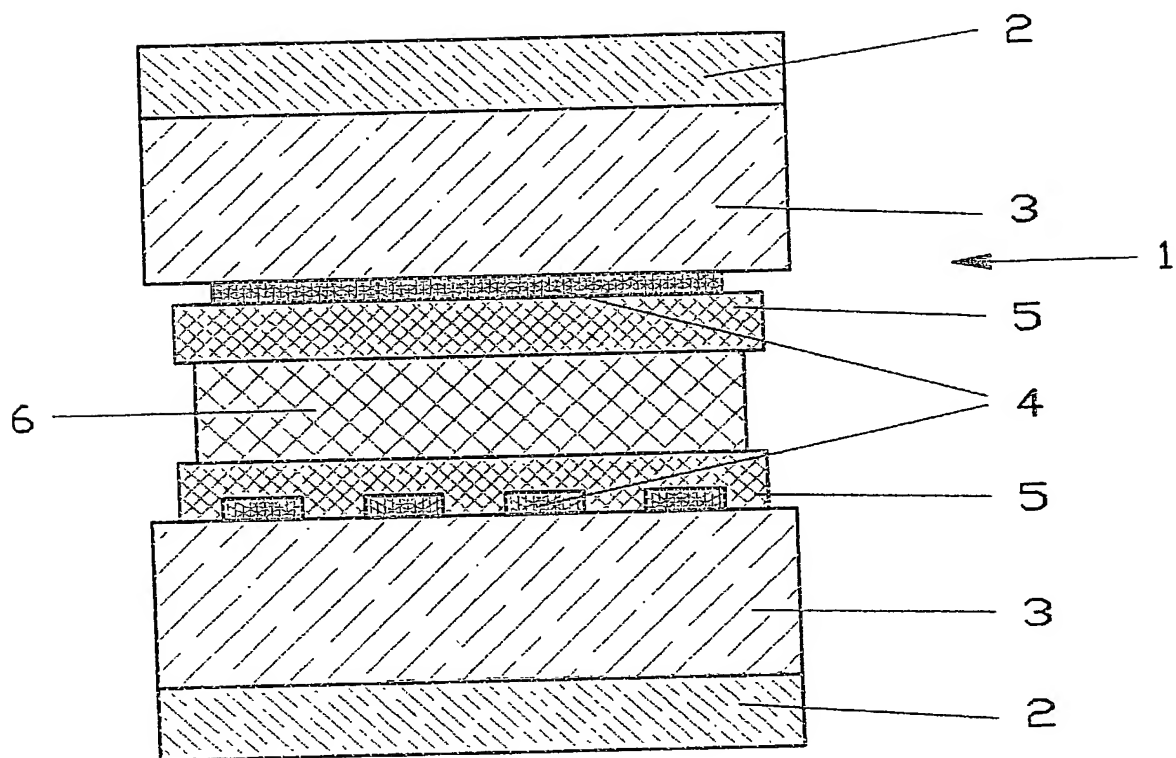


Fig. 1

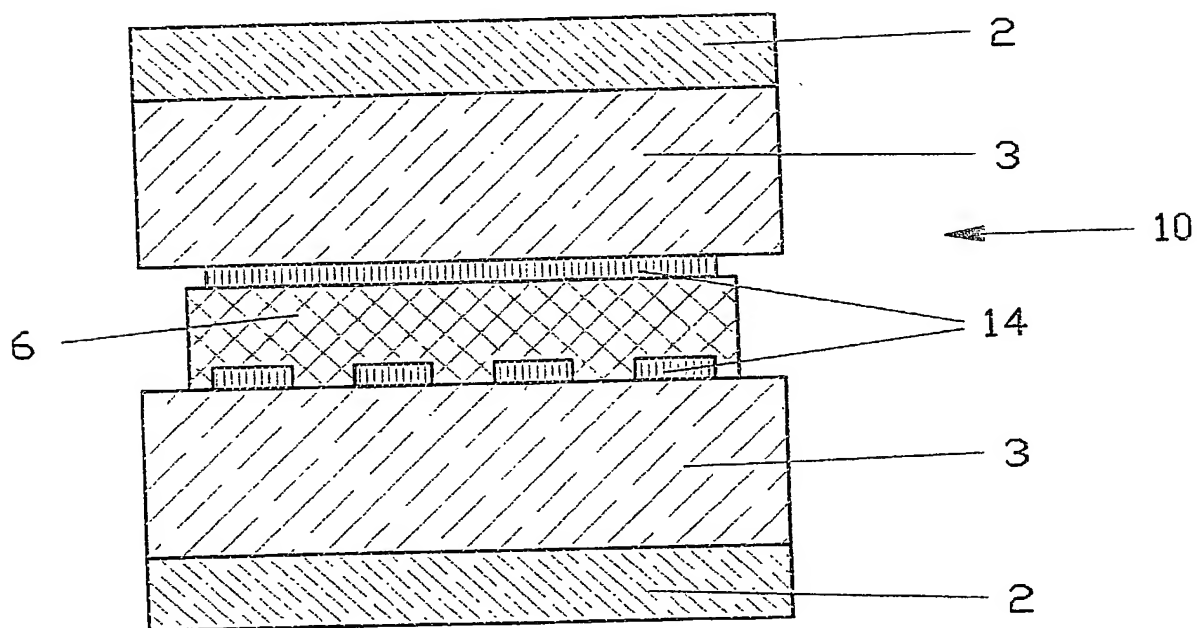


Fig. 2

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DECLARATION AND POWER OF ATTORNEY FOR NATIONAL STAGE OF PCT PATENT APPLICATION

As a below-named inventor, I hereby declare that:

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My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **A LAYER THAT CONTAINS ELECTRICALLY CONDUCTIVE, TRANSPARENT MATERIAL, A METHOD FOR PRODUCING SUCH A LAYER, AND THE USE OF SAID LAYER** the specification of which was filed as PCT International Application number PCT/DE 00/02234 on July 8, 2000.

I hereby state that I believe the named inventor or inventors in this Declaration to be the original and first inventor or inventors of the subject matter which is claimed and for which a patent is sought.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365 (b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior foreign application(s):

Priority claimed:

<u>199 33 843.4</u>	<u>GERMANY</u>	<u>July 20, 1999</u>	<u>X</u>	
(Number)	(Country)	(Date filed)	Yes	No
<u> </u>	<u> </u>	<u> </u>	Yes	No
(Number)	(Country)	(Date filed)	Yes	No

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I hereby declare that all statements made herein of my own knowledge are true and that all statements

made on information and belief are believed to be true; and further that these statements were made with the knowledge that wilful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statement may jeopardize the validity of the application or any patent issued thereon.

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